



Elimination of Abnormal Combustion in a Hydrogen-Fueled Engine

Subcontractor

University of Miami

Principal Investigator

Michael Swain
College of Engineering
University of Miami
P.O. Box 248294
Coral Gables, FL 33124-0624
(305) 284-3321

DOE Project Manager

John Garbak
U.S. Department of Energy
CE-332, MS 6A-116/Forrestal
1000 Independence Avenue, SW
Washington, D.C. 20585
(202) 586-1723

NREL Technical Monitor

Brent Bailey
NREL
1617 Cole Boulevard
Golden, CO 80401
(303) 275-4468

Subcontract Number

XR-2-11175-03

Performance Period

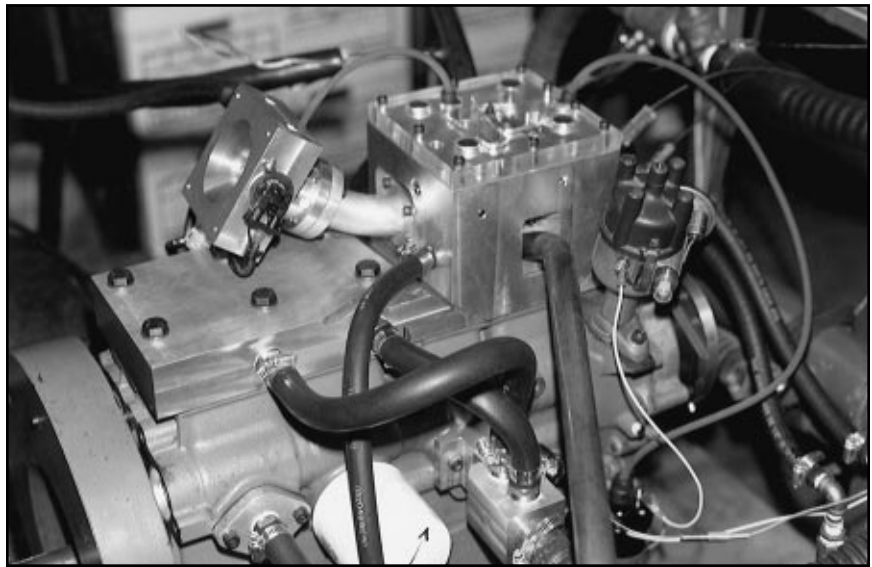
4/92–4/95

NREL Subcontract Administrator

Scott Montgomery (303) 275-3193

Objective

To determine whether a dedicated hydrogen-fueled engine can operate efficiently while carrying a high load under normal driving conditions and still emit low oxides of nitrogen (NO_x) and have normal combustion.



Hydrogen fuel induction system on the test engine

Approach

An engine has been constructed to suit the combustion properties of hydrogen. The design required the machining of a three-valve, two-spark plug aluminum billet cylinder head that incorporated machined cooling passages to eliminate film boiling. The engine incorporates the following modifications:

- The crank shaft was lengthened by welding and remachining
- The piston-connecting rod assembly was redesigned to allow full floating piston pin operation and 0.001-inch piston skirt clearance
- The camshafts were reground to various valve timing configurations
- A dual coil ignition system was designed
- An electronically controlled hydrogen fuel injection system was designed
- A tuned exhaust system was designed.



Accomplishments

The engine has been built. At loads typical of normal driving conditions, efficiency was good and NO_x emissions were low. High load operation was possible, but we could not operate the engine at length without abnormal combustion. The abnormal combustion was traced to the presence of oil in the combustion chamber.

Future Direction

The piston has been extensively modified to improve oil control. After the engine is reassembled, it will be retested with the new crank shaft, connecting rod, and piston.

Hydrogen Engine Data

RPM	1000	1800	2830	1000	1800	2830
Volumetric Efficiency (%)	79.0	84.6	87.9	79.2	84.9	88.2
Equivalence Ratio	0.4	0.4	0.4	0.5	0.5	0.5
BMEP (psi)	37.1	36.3	30.7	46.8	48.4	42.8
FMEP (psi)	21.1	30.5	42.7	21.1	30.5	42.7
IMEP (psi)	58.2	66.8	73.4	67.9	78.9	85.5
ITE (%)	36.0	38.6	40.7	34.8	37.7	39.3
Spark Advance (°BTDC)	23	27	31	15	17	20
NO _x (ppm)	7.4	7.9	10.2	45	71	90
NO (ppm)	5.1	6.0	8.4	41	64	88

Publications

Swain, M.R.; M.N. Swain. 1995. *Elimination of Abnormal Combustion in a Hydrogen Fueled Engine*. University of Miami. Final Report, NREL/TP-425-8196. October.